

Missouri's Water Quality Review Process for NPDES Permits

September 5, 2006



**Department of Natural Resources
Water Protection Program
Water Pollution Control Branch**

Water Quality Based Effluent Limits & the Clean Water Law

“...to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters.” [33 U.S.C. § 1251 (a)]

- ◆ Objective of maintaining water quality standards through appropriately established permit conditions
- ◆ Water Quality Review process is used to document appropriate effluent limits and monitoring requirements
- ◆ The review process also determines whether technology or water quality based effluent limits are necessary to restore and maintain water quality.

Water Quality Review Elements

- ◆ Site Specific Information
- ◆ Mixing Considerations
- ◆ Effluent Characteristics & Permit Conditions
- ◆ Derivation and Discussion

Water Quality Review Elements

- ◆ Site Specific Information

- Facility
- Receiving Waterbody

- ◆ Mixing Considerations

- ◆ Effluent Characteristics & Permit Conditions

- ◆ Derivation and Discussion

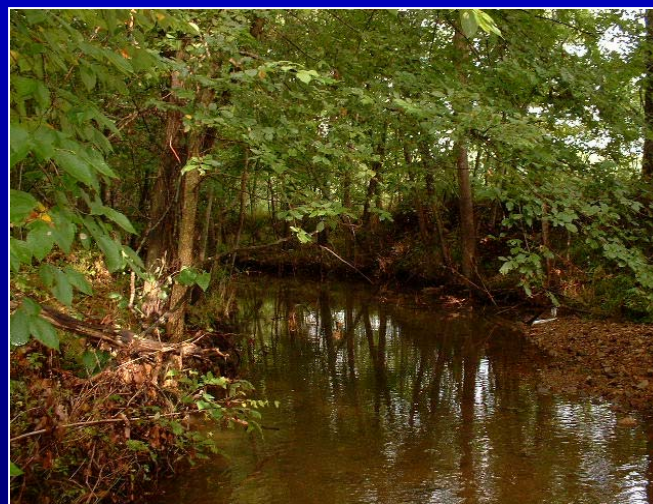
Site Specific Information



Facility

Anytown WWTF
Little Muddy Creek

Receiving Waterbody



Facility Information - General

- ◆ Facility Name
- ◆ Permit Number (for existing facilities)
- ◆ Facility Type/Description
- ◆ Legal Description
- ◆ Latitude/Longitude
- ◆ Water Quality History

Facility Information - Outfall

- ◆ Outfall Number
- ◆ Design Flow (gpd or MGD)
- ◆ Treatment Type
 - Primary
 - Secondary
 - Advanced
 - Stormwater
- ◆ Receiving Waterbody

Receiving Waterbody Information

- ◆ Waterbody Name
- ◆ Classification
 - Lakes (L1, L2, and L3)
 - Streams (P, P1, and C)
 - Wetlands (W)
 - Unclassified
- ◆ Low flow conditions (7Q10, 1Q10, 30Q10)
- ◆ Designated Beneficial Uses
 - IRR, LWW, AQL, CLF, CDF, WBC, SCR, DWS, IND
 - General Criteria - 10 CSR 20-7.031(3)
- ◆ Other Characteristics

Low Flow Conditions (7Q10, 1Q10, 30Q10, etc)

Site Specific

- ♦ **DIRECT** - Obtain low flow conditions through a statistical analysis of stream flow data
 - USGS stream flow data
 - USGS SWSTAT software
- ♦ **INDIRECT** - Watershed Area Ratio
 - Low flow statistics from similar watershed
 - Use ratio of watershed areas to obtain estimate
- ♦ **DEFAULT** - Waterbody Classification
 - Class P streams = 0.1 cfs
 - Class C and unclassified streams = 0.0 cfs

Conservative

Resource Requirements

Water Quality Review Elements

- ◆ Site Specific Information

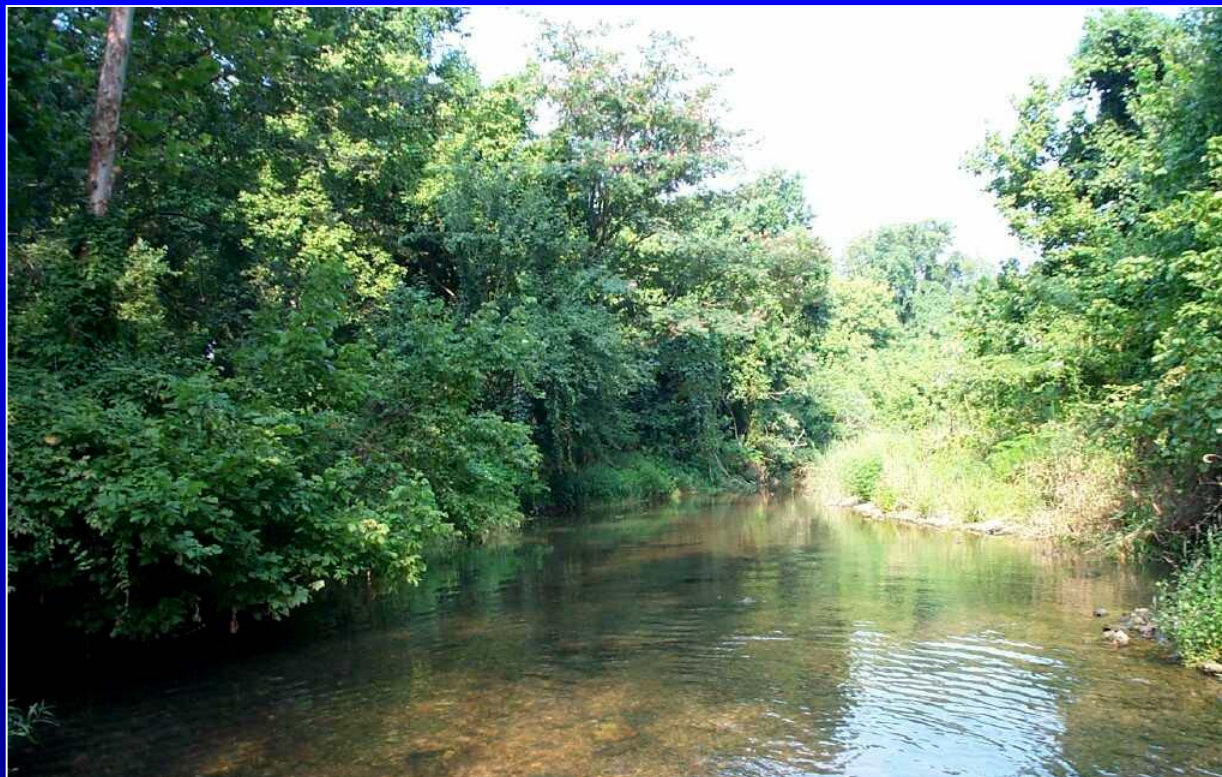
- ◆ Mixing Considerations

- Mixing Zone
- Zone of Initial Dilution

- ◆ Effluent Characteristics & Permit Conditions

- ◆ Derivation and Discussion

Mixing Considerations



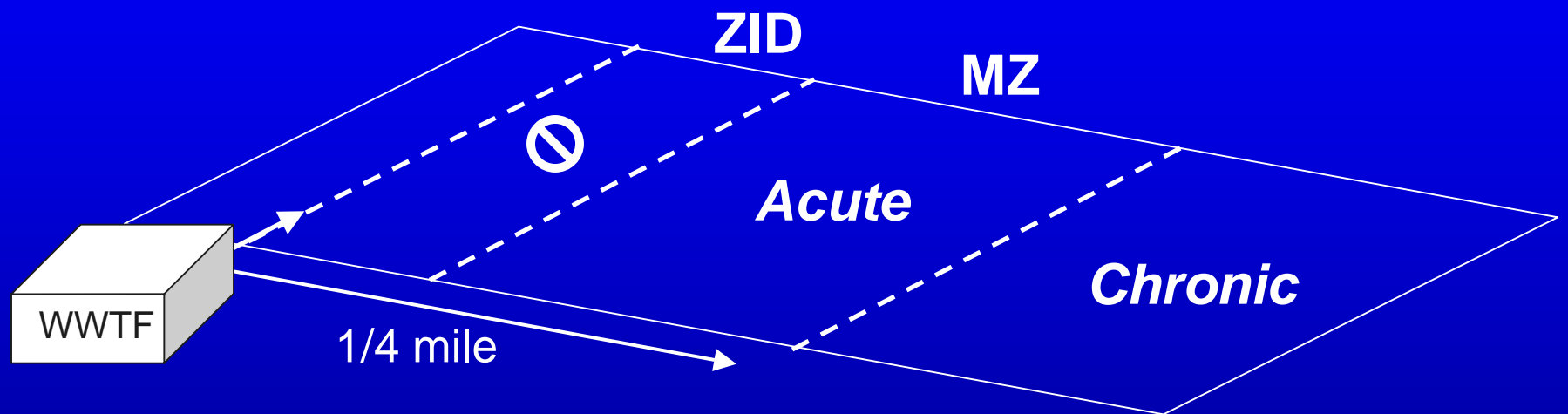
Honey Creek (WBID: 3245)
McDonald County

Mixing Zones

Mixing zones are areas of limited size near a facility outfall where numeric water quality criteria may be exceeded.

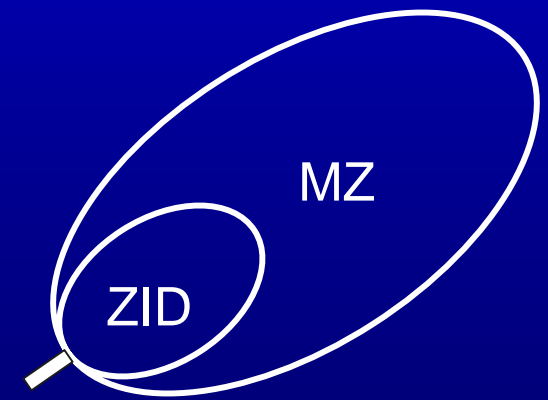
- ◆ General Criteria found in 10 CSR 20-7.031(3) must be met
- ◆ Zones of passage must be provided to avoid lethality to passing organisms
- ◆ Limited in size (volume, area, length) so that designated beneficial uses and aquatic communities are not adversely impacted

Regulatory Mixing Zones



MZ = Mixing Zone

ZID = Zone of Initial Dilution



Numeric Water Quality Criteria

- ◆ Chronic Criteria
 - Apply to classified waters
 - Apply at the edge of the mixing zone
 - Effects evident after 4 or 30 days of exposure

- ◆ Acute Criteria
 - Apply to classified and unclassified waters
 - Apply at the edge of the zone of initial dilution
 - Apply at all times in unclassified waters
 - Effects evident after 1 hour of exposure

Water Quality Review Elements

- ◆ Site Specific Information
- ◆ Mixing Considerations
- ◆ Effluent Characteristics & Permit Conditions
 - Effluent Limitations
 - Monitoring Requirements
- ◆ Derivation and Discussion

Effluent Characteristics & Permit Conditions



Anytown WWTF - Outfall #001
Calaveras County

Effluent Characteristics & Permit Conditions

- ◆ Sources of information for effluent characteristics
 - Permit application
 - Existing permit
 - File and effluent data review
- ◆ Determine effluent limitations for technology based “conventional” pollutants (BOD, TSS, pH, bacteria, and Oil & Grease)
- ◆ Determine reasonable potential for “non-conventional” and “toxic” pollutants

Water Quality Based Effluent Limits (WQBELs)

- ◆ Where reasonable potential exists, establish an effluent limitation; otherwise, establish a monitoring only requirement
- ◆ Consider all applicable designated uses and criteria when calculating wasteload allocations (WLA)
 - Chronic vs. Acute at appropriate dilution flows
 - AQL vs. DWS criteria at appropriate dilution flows

Water Quality Criteria

Magnitude

Duration

Frequency



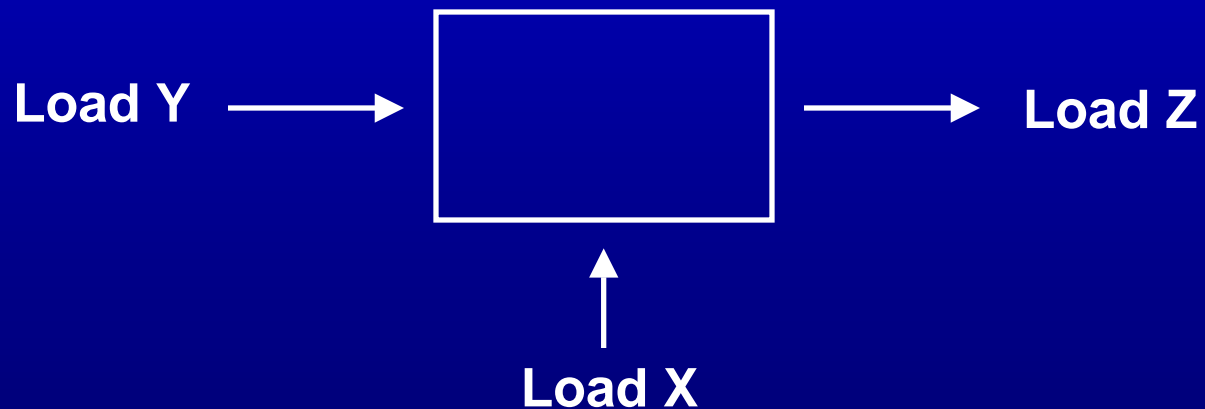
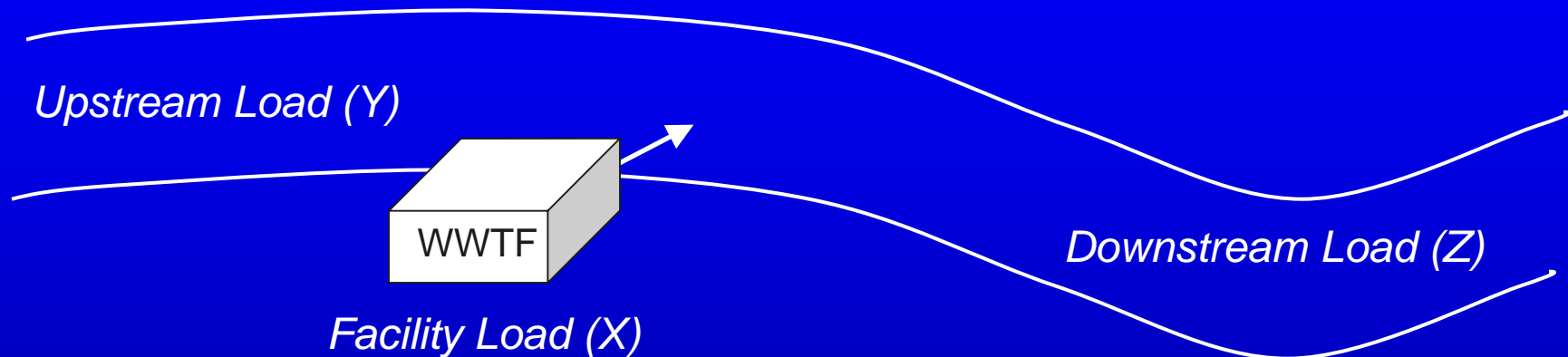
WLA

Effluent Limitation

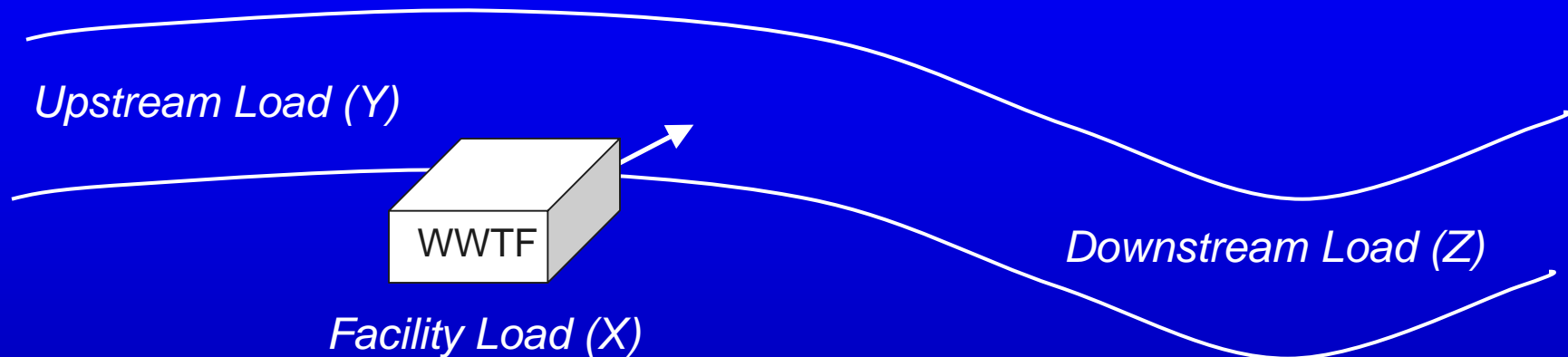
Magnitude

Averaging Period

WQBEL Calculation - Example



WQBEL Calculation - Example

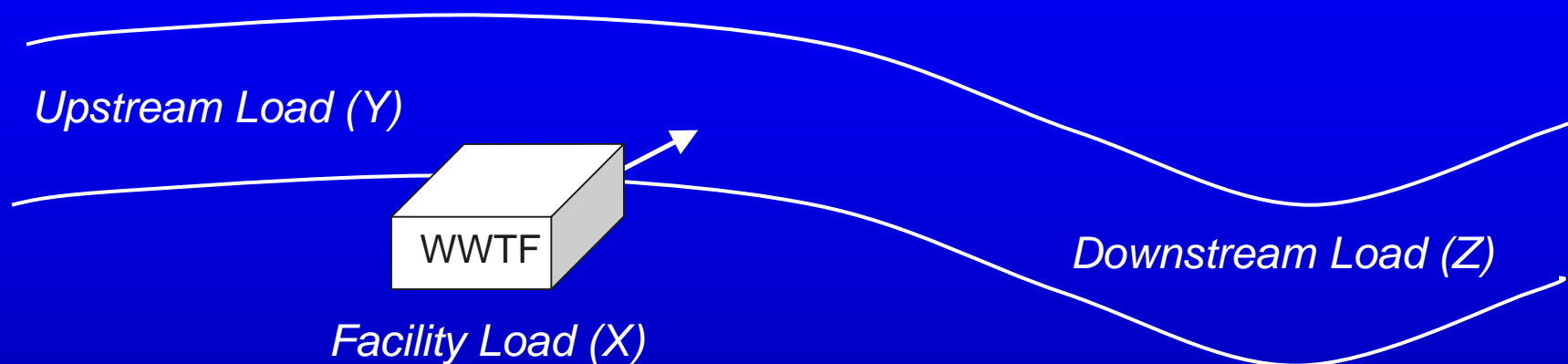


$$\text{Flow} \times \text{Concentration} \times CF = \text{Load}$$

Flow (Q) - gallons/day, cubic feet/second

Concentration (C) - milligrams/liter, micrograms/liter

WQBEL Calculation - Example



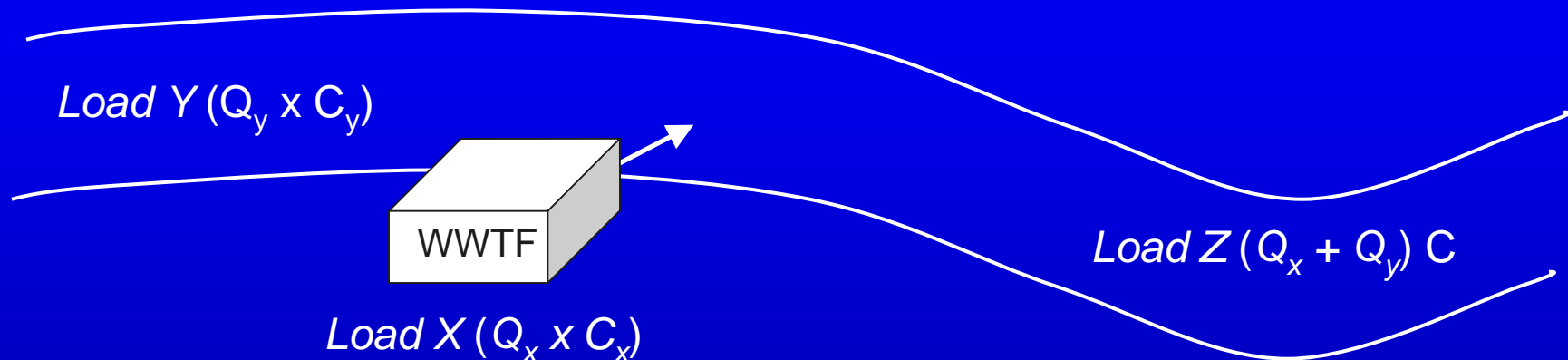
$$\text{Load } X + \text{Load } Y = \text{Load } Z$$

$$(Q_x \times C_x) + (Q_y \times C_y) = (Q_x + Q_y) \times C$$

Flow (Q) - gallons/day, cubic feet/second

Concentration (C) - milligrams/liter, micrograms/liter

WQBEL Calculation - Example

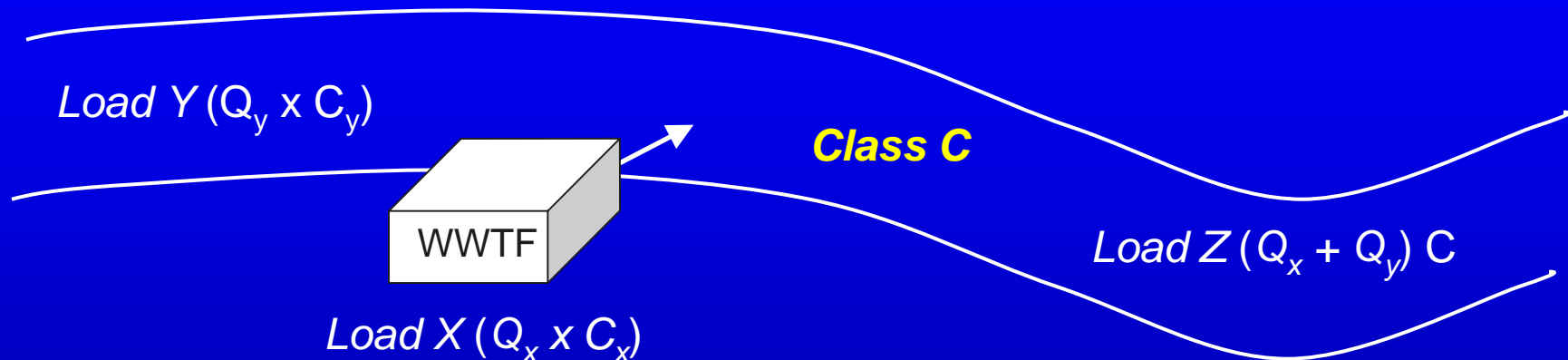


$$Q_x C_x + Q_y C_y = (Q_x + Q_y) C$$

Where:

- Q_x = WWTF effluent flow
- C_x = WWTF wasteload allocation
- Q_y = Upstream flow available for mixing
- C_y = Existing water quality of receiving water
- C = Water Quality Criterion

WQBEL Calculation - Example



$$Q_x C_x + Q_y C_y = (Q_x + Q_y) C$$

Where: Q_x = WWTF effluent flow = 1.55 ft³/sec

C_x = WWTF wasteload allocation = ??? mg/L

Q_y = Upstream flow available for mixing = 0.0 ft³/sec

C_y = Existing water quality of receiving water = 0.01 mg/L

C = Water Quality Criterion = 1.5 mg/L

WQBEL Calculation - Example (Part 1)

$$Q_x C_x + Q_y C_y = (Q_x + Q_y) C$$

$$(1.55 \text{ cfs} \times C_x) + (0.0 \text{ cfs} \times 0.01 \text{ mg/L}) = (1.55 \text{ cfs} + 0.0 \text{ cfs}) 1.5 \text{ mg/L}$$

$$(1.55 \text{ cfs} \times C_x) = (1.55 \text{ cfs} + 0.0 \text{ cfs}) 1.5 \text{ mg/L} - (0.0 \text{ cfs} \times 0.01 \text{ mg/L})$$

$$(1.55 \text{ cfs} \times C_x) = (1.55 \text{ cfs} + 0.0 \text{ cfs}) 1.5 \text{ mg/L}$$

$$C_x = (2.325 \text{ cfs} \cdot \text{mg/L}) / 1.55 \text{ cfs} = \mathbf{1.5 \text{ mg/L}}$$

$$C_x = \text{WLA} = 1.5 \text{ mg/L}$$

WQBEL Calculation - Example (Part 2)

$$C_x = WLA = 1.5 \text{ mg/L}$$

WLA converted into a Long Term Average (LTA) effluent concentration that will meet the criteria design characteristics

$$LTA = WLA \times \text{Factor} \quad (\text{CV} = 0.6, 99\text{th percentile}, n = 30)$$

$$LTA = 1.5 \text{ mg/L} \times 0.780 = 1.2 \text{ mg/L}$$

WQBEL Calculation - Example (Part 3)

Long Term Average (LTA) = 1.2 mg/L

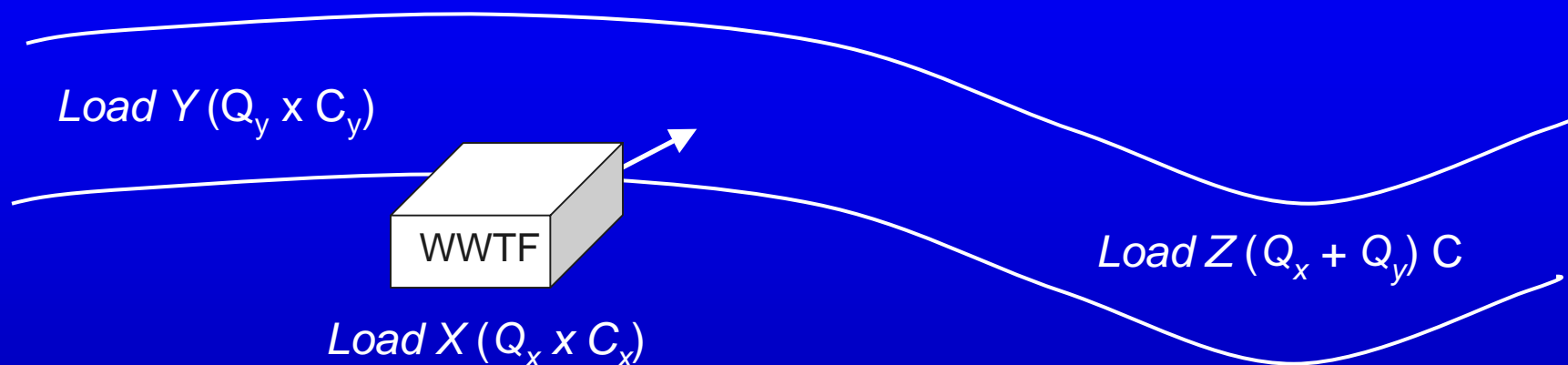
Maximum Daily and Average Monthly effluent limitations are then calculated from the most protective LTA concentration

Maximum Daily Limit (MDL)
Average Monthly Limit (AML)

$$\text{MDL} = \text{LTA} \times \text{Factor} = 1.2 \text{ mg/L} \times 3.11 = 3.7 \text{ mg/L}$$

$$\text{AML} = \text{LTA} \times \text{Factor} = 1.2 \text{ mg/L} \times 1.55 = 1.9 \text{ mg/L}$$

WQBEL Calculation - Example (Final)



$$Q_x C_x + Q_y C_y = (Q_x + Q_y) C$$

Maximum Daily Limit = 3.7 mg/L (31 lbs/day)

Average Monthly Limit = 1.9 mg/L (16 lbs/day)

“Technical Support Document for Water Quality-based Toxics Control”
EPA/505/2-90-001

Monitoring Requirements

Monitoring requirements are necessary to determine concentrations of chemicals of concern, validate model assumptions, and determine compliance with water quality standards

- ◆ Effluent Monitoring

- Minimum requirements based on flow in 10 CSR 20-7.015
- Effluent data used to determine reasonable potential
- Whole Effluent Toxicity (WET) Testing

- ◆ Instream Monitoring

- Monitoring location can be upstream, downstream, or both
- Minimum frequency determined by data needs and BPJ

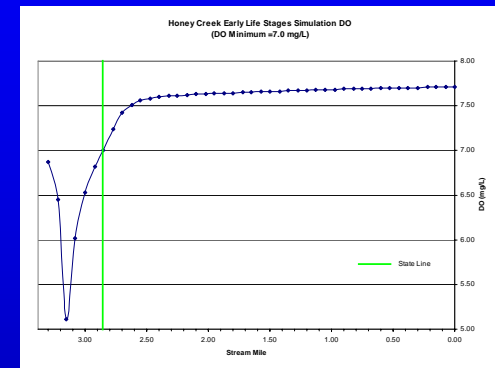
Water Quality Review Elements

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Derivation and Discussion

Table B2. Chronic Criteria for Total Ammonia Nitrogen (mg N/L): Early Life Stage absent₍₃₎₍₄₎

	Temperature (°C)																
pH	0-7	8	9	10	11	12	13	14	15	16	18	20	22	24	26	28	30
6.5	10.8	10.1	9.5	8.9	8.3	7.8	7.3	6.8	6.4	6.0	5.3	4.6	4.1	3.6	3.1	2.8	2.4
6.6	10.7	9.9	9.3	8.7	8.2	7.7	7.2	6.7	6.3	5.9	5.2	4.6	4.0	3.5	3.1	2.7	2.4
6.7	10.5	9.8	9.2	8.6	8.0	7.5	7.1	6.6	6.2	5.8	5.1	4.5	3.9	3.5	3.0	2.7	2.3
6.8	10.2	9.5	8.9	8.4	7.9	7.4	6.9	6.5	6.1	5.7	5.0	4.4	3.8	3.4	3.0	2.6	2.3
6.9	9.9	9.3	8.7	8.1	7.6	7.2	6.7	6.3	5.9	5.5	4.8	4.3	3.7	3.3	2.9	2.5	2.2
7.0	9.6	9.0	8.4	7.9	7.4	6.9	6.5	6.1	5.7	5.3	4.7	4.1	3.6	3.2	2.8	2.4	2.1
7.1	9.2	8.6	8.0	7.5	7.1	6.6	6.2	5.8	5.4	5.1	4.5	3.9	3.5	3.0	2.7	2.3	2.0
7.2	8.7	8.2	7.6	7.2	6.7	6.3	5.9	5.5	5.2	4.9	4.3	3.7	3.3	2.9	2.5	2.2	1.9
7.3	8.2	7.7	7.2	6.7	6.3	5.9	5.6	5.2	4.9	4.6	4.0	3.5	3.1	2.7	2.4	2.1	1.8
7.4	7.6	7.2	6.7	6.3	5.9	5.5	5.2	4.8	4.5	4.3	3.7	3.3	2.9	2.5	2.2	1.9	1.7
7.5	7.0	6.6	6.2	5.8	5.4	5.1	4.8	4.5	4.2	3.9	3.4	3.0	2.6	2.3	2.0	1.8	1.6
7.6	6.4	6.0	5.6	5.3	5.0	4.6	4.3	4.1	3.8	3.6	3.1	2.7	2.4	2.1	1.9	1.6	1.4
7.7	5.8	5.4	5.1	4.7	4.0	4.2	3.9	3.7	3.4	3.2	2.8	2.5	2.2	1.9	1.7	1.5	1.3
7.8	5.1	4.8	4.5	4.2	4.4	3.7	3.5	3.2	3.0	2.8	2.5	2.2	1.9	1.7	1.5	1.3	1.1
7.9	4.5	4.2	3.9	3.7	3.5	3.2	3.1	2.8	2.7	2.5	2.2	1.9	1.7	1.5	1.3	1.1	1.0
8.0	3.9	3.7	3.4	3.2	3.0	2.8	2.6	2.5	2.3	2.2	1.9	1.7	1.5	1.3	1.1	1.0	0.8
8.1	3.4	3.1	2.9	2.8	2.6	2.4	2.3	2.1	2.0	1.9	1.6	1.4	1.2	1.1	1.0	0.8	0.7
8.2	2.9	2.7	2.5	2.4	2.2	2.1	1.9	1.8	1.7	1.6	1.4	1.2	1.1	0.9	0.8	0.7	0.6
8.3	2.4	2.3	2.1	2.0	1.9	1.7	1.6	1.5	1.4	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.5
8.4	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.7	0.7	0.6	0.5	0.4
8.5	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.5	0.4	0.4
8.6	1.4	1.4	1.3	1.2	1.1	1.0	1.0	0.9	0.8	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3
8.7	1.2	1.1	1.1	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.2
8.8	1.0	1.0	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.4	0.4	0.3	0.3	0.2	0.2
8.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2
9.0	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.1



$$Q_x C_x + Q_y C_y = (Q_x + Q_y) C$$

Derivation and Discussion

- ◆ Rationale for effluent limitations and monitoring requirements and how they were derived
- ◆ Includes all criteria and calculations used, low flow statistics, and water quality model inputs/outputs
- ◆ Caveats and disclaimers

Questions?

